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A NOISE LEVEL SURVEY OF THE CITY OF REGINA

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A
NOISE LEVEL SURVEY
OF THE
CITY OF REGINA

Prepared by the
Community Noise Control Division
of the
Air Pollution Control Branch
Environment Saskatchewan

February, 1977

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1. INTRODUCTION

Environment Saskatchewan is the government agency responsible for the development of a province wide community noise pollution control program. It became apparent early in the development of the program that the majority of community noise complaints could be best handled at the municipal level. Accordingly, in late 1974 the Air Pollution Control Branch began the preliminary work required to design an effective municipal Noise Control Bylaw. An important aspect of its development was a detailed study of noise levels presently occurring in Saskatchewan cities. A background sound level survey was undertaken to collect information about the nature of sound levels in Regina.

Instrumentation was set up at several locations to continuously monitor the sound levels over twenty-four hour periods. The resultant data presented in this report shows the variation of sound levels over the twenty-four hour periods and also indicates when and where the maximum sound levels occur. The data enables a comparison of sound levels between different areas of the city and to other cities where similar information is available. Most important however, will be the establishment of baseline reference levels for future comparison and evaluation of noise abatement programs.

Since this report is intended to be read by various people, a section describing noise and its affects on people is included. Some of the information contained in that chapter may seem exaggerated however, it has all been documented by medical research. Noise is interpreted by the body as stress and will produce many of the same symptoms.

2. SUMMARY AND CONCLUSIONS

The data collected during the past several months indicates that while Regina is a relatively quiet city it does have certain noise problems.

The worst of these is transportation noise, both on the ground and in the air. Vehicular noise is the major component of the ambient sound level and at some locations is the only significant noise source. While this problem is particularly acute near arterial and collector roadways it is not restricted to such areas. As the miles of roads and number of vehicles increases annually the noise problem grows proportionately. More consideration must be devoted to this aspect of land use planning in the future development of residential areas and traffic routes.

Trains, although much fewer in number, also contribute to the problem. This condition will no longer exist in most areas of Regina when the CN and CP marshalling yards are relocated to north-east Regina in the near future. That will be a welcomed change to the noise environment.

Airport noise is a problem in most urban areas and Regina is no exception. In some areas of the city the problem is critical. The recent strike by the Canadian Air Line Pilots Association provided an excellent opportunity to assess the contribution the large jet

aircraft have on overall sound levels. At one particular site the L_{eq}* decreased by 13 dB(A) during the strike. This is very significant and in fact, would be subjectively rated as less than half as loud as before the strike. Surprisingly, the L_{eqs} measured in the vicinity of the airport are very comparable to those measured near other kinds of transportation noise sources such as busy streets or in the vicinity of railroad activity.

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* L_{eq} is a measure of the constant noise level at a site that contains the same energy as the time-varying noise. It is defined on Page 13.

3. SOUND AND NOISE

The purpose of this section is to acquaint the reader with some background information on sound and its measurement. This knowledge will enable a better understanding of the remainder of this report.

Society has attempted to control excessive or unwanted sound since time began. The ancient Romans, by popular decree, prohibited the riding of chariots through town after dark because of the noise they created. Contemporarily, the problem has increased because of the number of vehicles and technological devices in use. Average, ambient sound levels are said to be increasing at the rate of one decibel per year. This means a tenfold increase every decade. If this trend continues, noise will become a serious detraction from the quality of life in most urban areas.

Only by adopting and actively enforcing effective legislation will the struggle against noise pollution be won. As with most legislation, the laws required to protect or to enhance our environment have been slow to change. Let us hope that a crisis does not have to occur with noise pollution before serious action is taken.

3.1 What is Sound?

When somebody claps their hands or strikes a gong the air around the activity is set into motion and as in water, the air radiates outwards from the disturbance in waves. These waves

are actually minute compressions and rarefications of the air in alternating waves. These variations in sound pressure are picked up by the ear drum and are perceived as sound.

The human ear is an extremely sensitive organ composed of three distinct sections: the outer, the middle and the inner ear. The outer ear is the visible part whose purpose is to channel the sound waves into and down the ear canal to the ear drum. The ear drum, which separates the outer and middle ear, is a very thinly stretched layer of skin which vibrates in sympathy to these pressure changes very much like a loud-speaker diaphragm vibrates. The middle ear is an area in which a complex system of bone-like levers transmit and amplify the movement of the ear drum. The pressure waves caused by the bone movements in the middle ear send undulations down a spiral shaped, fluid-filled canal which excites several thousand small nerve cells. The movement of these nerve cells produces an electric current which is transmitted to the brain and then perceived as sound.

Each sound has several important characteristics which we are quite familiar with. The term pitch or tone is one. This characteristic is measured in cycles per second or more commonly in Hertz and is determined by the frequency of a sound or the number of times per second that the air waves pass a particular point.

A low pitched bass singer can emit notes with primary frequencies as low as 60 to 70 Hertz, while a soprano singer can reach approximately 1,300 Hertz. A piano's frequency range extends from approximately 30 to 4,200 Hertz with middle "C" being 261.3 Hertz. A large pipe organ can produce notes which span almost the entire range of audible sounds with fundamental tones to the lower threshold of hearing and upper notes approaching 10,000 Hertz. A person with excellent hearing should be able to detect sounds with frequencies from approximately 15 to 20,000 Hertz.

Another characteristic of all sounds is their wavelength. This is simply the distance between two successive waves and it is measured in feet or fractions thereof. Wavelength is not a directly measured quantity as is frequency but it is calculated from the frequency and the speed of sound. At normal room temperature sound waves travel at 1,128 feet per second or approximately 770 miles per hour.

3.2 The Decibel

The human ear is sensitive to a very wide range of frequencies. It would be almost impossible to include this range on a linear scale so a logarithmic scale is used. The decibel, the unit used to measure sound, shows how many times one value, say x, is greater or lesser than a second value, a standard reference value. Please refer to Table 1 on Page 14.

Decibels are not added together as are linear units. If we add one 80 decibel sound to a second 80 decibel sound, we do not have 160 decibels. The sounds are additive, but the decibel scale is based on ratios. To combine decibel readings from different sources the procedure is to convert the decibels back to fundamental units of sound power (not pressure), add them and then convert the result back to decibels. For example, the addition of two 80 decibel sounds will result in a total of 83 decibels. Doubling of the noise source will result in a doubling of the sound energy and hence, a three decibel increase.

It is not necessary at this time to understand how a decibel is derived. It is helpful however, to remember that an increase of about three decibels is a doubling of the sound energy while increasing the sound by ten decibels will double its apparent loudness.

3.3 Effects of Noise

As previously mentioned, the response of the human ear is very complicated. We know that the ear detects both frequency and loudness however, the perceived loudness depends upon the frequency. At very low frequencies, a sound must be much higher in intensity to be judged equally as loud as a high pitched sound. A sound level meter measures all sounds at all frequencies equally so a special weighting network has been incorporated into

sound level meters to simulate the human response. The "A" weighted scale suppresses, by increasing amounts, frequencies below about 500 Hertz. It has been proven that the "A" scale very accurately predicts the human response to most community noise situations. For this reason it is used almost exclusively for judging annoyance or the human response to a particular sound.

As well as being very annoying, excessive sound or noise can have other more serious effects. It is now believed that sound levels of 75 to 85 dB(A) can have serious side effects on our hearing and can indeed cause irreversible, permanent damage to our ears with time. This is only one of the ways that noise can take its toll. Sound levels of 35 to 45 decibels can disturb a sleeping person and levels of 50 to 60 dB(A) can interrupt normal conversation. Levels of 80 to 90 dB(A) can cause stress reactions. Most sounds are interpreted by the human mind as stress and a sound of moderate volume in short duration such as an automobile back-fire can produce a remarkable number of internal changes. Blood vessels in the brain dilate while bodily vessels constrict. The blood pressure in turn rises and the heart rhythm changes. The blood cholesterol level rises sharply and various endocrine glands pour hormones into the blood stream. Even the stomach changes its rate of acid secretion. Most of these changes are temporary but our environment

presents such transitory sound levels that some of these symptoms may become chronic.

Ulcers, indigestion, heart burn and heart disease are all connected to stress in general and since noise is interpreted by the body as stress, it may be a contributing factor to these disease conditions. These are only a few of the more well documented effects of noise. These statements may seem alarming and they should because they are not exaggerations. Noise pollution has reached the point that, unless controlled, it could become a major social problem.

3.4 Desirable Sound Levels

Most environmental guidelines or regulations are designed to protect the public from the adverse effects of pollution. An Leq of 70 decibels or less is considered sufficient to protect virtually the entire population from any hearing loss induced from noise exposure. This is the absolute minimum that must be protected. Regulations should also ensure that people are protected from other, more subjective responses. Noise can cause annoyance, activity interference and a wide range of subjective maladies without causing any physical changes.

As people move through their normal daily routine whether it is as a housewife, a boiler maker or a farmer, their hearing will

not be impaired if the daily equivalent of sound energy in his or her environment is no more than 70 decibels. Likewise, undue interference with activities and annoyance will not occur if outdoor levels are maintained at an Leq of less than 55 decibels and indoor levels are kept to a level of 45 decibels or less.

Other sources state that L_{10} levels in excess of 70 dB(A) are unacceptable (Edmonton Noise Survey) for residential use or that L_{50} levels from 55 to 70 dB(A) are normally unacceptable and only when L_{50} levels are in excess of 70 dB are noise levels clearly unacceptable (Calgary Noise Survey). What these statements indicate is that there is considerable disagreement over what is and what is not acceptable. Noise is a very subjective topic and often what one person considers noise, another will not. This makes the task of setting realistic legislative standards to control noise pollution very difficult.

The percentage exceedance levels or Lx levels used above are commonly used to describe the annoyance of a particular noise "environment." The more commonly used are the:

L_1 -- Maximum, very intrusive noises
L_{10} - Peaks, annoying noise
L_{50} - Median scund level
L_{90} - Background sound level
L_{99} - Minimum

The L_1 indicates the absolute or loudest sounds recorded and is not too indicative of the overall noise. The L_{10} level is a much better indication of the noise climate and some studies have used it for judging the annoyance of a particular sound climate. The L_{50} level represents the median sound level and is useful for assessing the average level of noise at a location. The L_{90} is the background sound level and gives a good indication of the lower noise levels while the L_{99} is usually given for interest only because it represents the lowest sound levels monitored and it usually follows the L_{90} contour very closely.

Another useful indicator of the annoyance of a particular sound climate is the range of the noise levels. This sound spread is usually represented by the difference between the L_{10} and the L_{90}. Often it is as useful to know what the variance in sound levels is as it is to know what the actual levels are. The wider the spread between the L_{10} and L_{90} the more annoying the sound environment will be. Locations which are monitored near truck routes or high-density roadways will usually have a narrow spread and are usually found to be less annoying.

The indicator relied upon most heavily for this study is the L_{eq}. Although a set of exceedance levels and the sound spread

will provide a wealth of information about a particular noise environment, there is a need for a measure that summarizes all the information into a single number. The energy equivalent sound level is very highly regarded for this purpose. The Leq is the sound level, in decibels, of the equivalent constant sound that, for the duration of the measurement period would generate the same total energy as does the measured sound. What this means is that if the energy levels of a sound are averaged instead of the pressure, the resultant Leq has a very good correlation with the annoyance.

TABLE I

TYPICAL SOUND LEVELS

SOUND INTENSITY FACTOR	SOUND LEVEL (dBA)	SOUND SOURCE
100,000,000,000,000	140	JET AIRCRAFT AT 25 METERS
10,000,000,000,000	130	TRESHOLD OF PAIN
1,000,000,000,000	120	LARGE PROPELLER AIRCRAFT AT 50 METERS
100,000,000,000	110	LARGE INDUSTRIAL SHOP
10,000,000,000	100	HEAVY DEISEL TRUCK AT 10 METERS
1,000,000,000	90	GAS LAWN MOWER AT 1 METER
100,000,000	80	BUSY STREET CORNER
10,000,000	70	INTERIOR OF CAR AT 110 K.P.H.
1,000,000	60	ORDINARY CONVERSATION AT 1 METER
100,000	50	BACKGROUND LEVEL, OFFICE BUILDING
10,000	40	SOFT BACKGROUND MUSIC
1,000	30	QUIET WHISPER
100	20	VERY QUIET TOWN – INDOORS
10	10	GENTLY RUSTLING LEAVES
1	0	THRESHOLD OF HEARING

4. NOISE SURVEY

4.1 Site Selection

An exhaustive sound level survey would require continuous twenty-four hour monitoring at several hundred locations throughout the city. To reduce the amount of monitoring required several sites were monitored which were considered to be representative of typical urban locations in the city.

There are several methods available to ensure adequate and representative sites are selected. One method is to use a grid method whereby the city is divided into equal areas by superimposing over it a grid map. This method yields several zones of equal area that do not consider the natural divisions in the city. Another approach is to divide, using geographical barriers such as railroad lines, truck routes and zoning barriers etc., the city into areas having similar noise climates. Both of these methods have their advantages and drawbacks.

This survey used a basically random approach. Regina, being a relatively homogenous city could be well sampled using the grid system however, that method places many restrictions on the location of the monitor. The site criteria used in this survey is similar to that of other surveys. Most locations are

typical urban sites. It is very important to ensure that the locations used would not be adversely influenced by some mechanical equipment such as an air conditioner or exhaust fan whose noise level would out-weigh the background sound levels.

All monitoring was done on typical weekdays to minimize the variance in sound level due to traffic changes however, some sites were monitored on both weekdays and weekends to assess the difference in sound levels associated with differing traffic patterns, recreational activities etc. Two locations which were dominated by aircraft noise were used to assess the impact aircraft have on the overall sound level. Each site was situated almost directly off the end of the No. 1 runway at Regina Airport. One site, on the northwest end, was particularly suitable because it is a very isolated location. Its noise climate is determined almost solely by the airport's operations. During a recent pilot's strike the opportunity arose to re-monitor that location without the large aircraft being in use. The results of this monitoring will be included in the data section.

Previous studies have always concluded that transportation noise was the largest component of the overall noise level. Any survey of noise levels must take this into consideration and

assess, to as great an extent as possible, how much transportation noise contributes to the sound environment.

4.2 Sampling Procedure

The most accurate method of sampling would be to continuously monitor noise levels over a period of several days and to report an average of the results. In this survey each site was monitored for at least one 24 hour period to ensure a representative sample.

Initially, the instrumentation consisted of a General Radio Precision Sound Level Meter (Model 1933) connected to a General Radio (Model 1521) Graphic Level Recorder. This combination of instruments has a 40 decibel dynamic range which in most circumstances proved adequate. While very accurate, this method required an overwhelming amount of data reduction. Its benefit is that the sound level, as it varies with time, is permanently recorded on a paper chart and it is possible to actually "see" the noise as it changed. The charts, fifty feet long for each 24 hour sample, were analysed using a digitizer interfaced with a computer card-punch machine. The cards were run through a computer program and the required information derived from the printout.

Recently, a second method has been used which almost totally eliminates all manual data handling. A General Radio Community

Noise Analyser (Model 1945) was acquired which automatically records and analyses the data.

This instrument is entirely portable and is very convenient to use. An internal clock may be used to delay, to a preset time, the hour at which the monitoring is to begin. It will then monitor the noise levels unattended for up to three separate consecutive twenty-four hour periods. It has a 100 decibel dynamic range which eliminates any loss of data due to its being outside the range of the instrument. At the end of the selected monitoring period the data is obtained by simply selecting the described information and recording it. As well as calculating several L_x levels it also calculates the Leq or L_{dn} when required.

5. RESULTS

5.1 The field data collected for this report would fill several volumes in its entirety so most of the information will be reported graphically and in tabular form. Space restrictions will not allow a detailed discussion of noise levels at each site but several will be discussed in sufficient detail to acquaint the reader with a complete noise "signature" for at least a few sites.

Graphically reported data will show the decile or percentage exceedance levels. These are simply the sound levels (L) exceeded x per cent of the time. The abbreviation for this is the Lx level. By reporting only one Lx level the reader could get an erroneous impression of the sound climate so it is always preferable to report several Lx levels.

Also reported is a one number description of the noise environment that will take all these variables into consideration. A complete description must include more than simply the sound level at a specific time. It should tell us how that level varied with time and it should indicate what range the sound varied over. It is necessary to choose between a very complicated measurement technique and one which is sophisticated and yet practical to use.

These considerations, as well as its wide general acceptance have lead to the use of the long-term average sound level or the energy equivalent level. The equivalent A weighted sound level is that constant sound level which contains the same sound energy as the actual time-varying sound level. The equivalent sound level is abbreviated Leq. It should be noted that all the data recorded in this report is for a twenty-four hour period unless otherwise stated. Because the Leq considers the total energy over a 24 hour period it will not exclude the occurrence a very high sound levels for relatively short periods of time. For example, an Leq of 60 dB will permit a sound level of 110 decibels during a twenty-four hour period but only for a total of one second.

5.2 Discussion

The data reveals that the City of Regina is not as noisy as comparable urban centres. This is not to say however, that Regina does not have its noise problems. In some areas of the city the problem is severe. In most cases, if there is a serious problem it is caused by some form of transportation noise.

The monitored Leqs have ranged from the high 40's to levels above 70 decibels. This is a significant spread especially when an increase of 10 decibels is a tenfold increase in sound power

and a doubling of the apparent loudness while a 20 decibel increase is a hundredfold the sound power and will be perceived as four times as loud. The difference between an Leq of 50 decibels and one of 80 decibels is a factor of a thousand times.

The Leq for a quiet rural area usually falls between 40 dB(A) and 45 dB(A). One of the quietest locations which has ever been monitored was on the north wall of the Grand Canyon where sound levels as low as 16 decibels have been measured. Other natural areas have been monitored and found to have Leqs in excess of 80 decibels near waterfalls or geysers. The range of natural sounds is very wide indeed and often a quiet site is hard to find because of the sounds of nature.

In Regina it was found that the quieter residential districts had Leqs in the upper forties and fifties. The quietest location monitored was on the 1700 Block of McIntosh Street where the Leq was only 48 dB(A). The average residential areas varied between 50 and 60 decibels. As a reference point, readings were collected in the small Town of Pense, Saskatchewan where the Leq was 53 decibels.

In contrast monitoring was done at the Albert Street and Victoria Avenue intersection. Here, where daily vehicle flows exceed 40,000 vehicles per day the twenty-four hour equivalent sound level was 75 dB(A). The second loudest site was adjacent

to a truck route over a poor road. The Leq at this location was 73 dB(A). This is excessively loud for a residential area.

Comparison of noise level maps and vehicle flow charts indicates a general correlation between vehicle flow and noise levels. It is possible to estimate approximate noise levels using traffic flow maps and a general knowledge of the area.

The minimum, accurately measurable sound level when using 1945 Community Noise Analyzer is approximately 26 decibels. These minimum sound levels are not indicative of the noise climate but they are interesting. The Lminimum dropped to below 30 decibels on occasion and it was not uncommon for it to be in the low thirties. The twenty-four hour L_{90} level also ranged in the low thirties on frequent occasions during the early morning hours.

The L_{50} sound exceedance level is that level of sound, in decibels, which is exceeded 50% of the time. It is the median sound level or approximately the average sound level. In several instances it did not exceed 50 decibels and seldom exceeded 55 decibels. Readings of this low a level were not expected for so many locations in Regina. These low sound levels after midnight reflect how few establishments are open 24 hours to serve the public. Many large cities have sufficient nightlife to maintain fairly high sound levels 24 hours per day.

The maximum measurable sound level using this equipment is 120 decibels. This level was attained or exceeded on only two occasions. One was beside a temporary truck route through a residential area while the second was in the vicinity of the airport. Any site monitored near a heavily used arterial or collector roadway or the ring road had significantly high Leqs and often they were similar in magnitude to those near the airport.

Air traffic, although affecting fewer people for less total time, causes an important aspect of Regina's noise pollution problem. The airport is a significant source of community noise. The problem has been created by the city allowing residential housing to be built upon the noise impacted land surrounding the airport and by the increase in the size and volume of air traffic. Two sites were picked which specifically consider the noise created by the operation of the airport and aircraft. One site was under the southeast end of No. 1 runway and located well within the 40 N.E.F.* contours as calculated by C.M.H.C. The Leq at this site was only 65 dB(A) which does not appear that high. Leq however, has never been considered to accurately forecast the annoyance caused by aircraft and in this instance understates the

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* Noise Exposure Forecast is a scale used by the Federal Government in land use planning in connection with airports. They indicate that at levels above 35 N.E.F. the annoyance caused by aircraft so severely effects the environment that residential development is discouraged.

actual noise level. The maximum sound level (Lmax) at this site was 103 decibels. Interestingly, the people living at this site said they were not bothered in the least by the aircraft and in fact, found them amusing.

The second site was under the opposite end of the runway. This site, on Courtney Street, is ideal for this purpose because there is no traffic within almost one-half mile and very little noise generated on the site. Any noise measured here would more than likely be from the planes and the occasional train. During the monitoring period, the Canadian Air Line Pilots Association went on strike and sound levels were monitored without the large passenger jets present. Under normal operating conditions, the L_{eq} at this location was about 69 dB(A) with maximum readings often exceeding 110 decibels. In contrast, during the strike the L_{eq} never exceeded 57 dB(A). This difference of 12 decibels in the equivalent sound level is a very significant amount.

In contrast to the people living at the previous site, these people were much more bothered by the planes but said they got used to it. The sound levels, which are virtually identical, are high enough to cause a great deal of annoyance.

Railroads have a similar effect on noise levels. One site particularly influenced by railroad noise was located a few hundred feet north of the CNR mainline in northeast Regina. The Leq was 57 dB(A). A second site across the street from the CNR switching yard and the CN trucking operation reported a 24 hour Leq of 66 dB(A) which was one decibel louder than a site monitored right inside the switching yards at the yardmaster's shed.

The reduction of noise levels which will be realized when the railyards are relocated to the northeast will be a welcomed change in Regina. Level crossings will virtually disappear and with them will go train whistles and all the other associated noises responsible for a considerable amount of annoyance.

Data from five consecutive days of monitoring at a site located adjacent to the Trans-Canada Bypass in southeast Regina indicates how constant the noise levels in some areas are. The maximum recorded level varied by only one decibel over the entire five day period staying consistently at 88 to 89 dB(A) both weekdays and weekends. This level is determined primarily by the large transport trucks using the bypass. The L_{20} sound levels were 61 dB(A) every day and the Leq averaged 61 dB(A) weekdays and 59 dB(A) weekends.

A very high correlation which was not previously detected between the L_{20} and the Leq was apparent at this site. The Leq usually falls between the L_{20} and the L_5 exceedance levels but is not predictable to any accuracy. There are however, a few formulae that may be applied to the Lx levels to estimate the Leq. Though helpful under some conditions they should not be relied upon as a replacement for directly monitoring the Leqs as they are only approximations under some conditions.

The Leq is often closely approximated by the L_{10} which has led to its acceptance as a good indicator of the noise environment. In this survey, the Leq usually fell between the L_{10} and the L_{20} sound level and was in fact most closely approximated by the L_{15} sound level.

The foregoing data indicates how widely the sound levels vary throughout the city. In fact, the noise environment is so dynamic that to obtain an "average" sound level at a particular site would be almost impossible. No two people are subjected to the same environmental noise exposure.

It is hoped however, that by representatively sampling as many areas as possible, Regina's noise climate will be accurately depicted. The monitoring of noise levels will continue indefinitely and, as sufficient amounts of data are collected, they will be incorporated into an updated survey of Regina's noise levels.

6. RECOMMENDATIONS

Noise pollution within a community is an extremely complex problem. To correct the present noisome situation will require all levels of government to become actively involved.

It is an accepted fact that the amount of success encountered by community noise control regulations depends to a large extent on the degree of public awareness and the understanding of the goals of the regulations. The steadily increasing numbers of requests for information about noise indicates that public awareness is growing and it is this department's belief that the time has come for more effective anti-noise bylaws.

This department maintains that:

(1) Proper land use planning would have eliminated many of the noise problem areas presently in existence. Municipal governments must begin to accept "community noise" as a prime consideration in land use planning and development.

(2) Through the media, an attempt should be made to educate the public about noise pollution to assist in the anticipation and avoidance of future noise problems and the alleviation of present problems. Many of the problems encountered by this department arise from the inconsiderate and unco-operative actions of people such as squealing tires, unnecessarily loud exhaust systems and locating potential noise sources such as air conditioners and exhaust fans in unacceptable places.

(3) The cities of the province should introduce and administer effective community noise control programs directed towards nuisance noises which are most amenable to local control.

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APPENDIX

This appendix includes brief descriptions of all the sites monitored as well as the noise data for each. Also included are several graphs displaying the hourly rise and fall of the sound levels over typical twenty-four hour periods.

SITE NUMBER AND LOCATION	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{20}	L_{10}	L_{1}	L_{MAX}	$L_{10}-L_{90}$	L_{eq}	SITE DESCRIPTION
1. 92 Dryburgh Cres.	25	28	31	38	45	50	60	90	19	53	residential with mostly local traffic
2. 58 Slinn Bay	33	36	40	45	49	52	57	66	12	49	residential, approximately 1000 feet to highway
3. 272 Oakview Drive	43	45	48	55	57	59	64	70*	11	56	residential on collector road (before ring road)
4. 126 Truddelle Cres.	22	26	32	39	46	52	67	101	20	57	residential with only local traffic, 200 ft. from CNR mainline
5. CNR Switching Yards	49	50	51	55	61	66	78	96	15	65	in yardmasters shed 60 feet from main tracks.
6. 469 Alexandra	54	55	57	64	67	68	70	74	11	66	corner lot on busy street at residential industrial interface

SITE NUMBER AND LOCATION	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{20}	L_{10}	L_1	L_{MAX}	$L_{10}-L_{90}$	L_{eq}	SITE DESCRIPTION
7. 400 Rae Street	26	27	28	37	51	56	69	100	28	59	corner lot in residential area - busy streets.
8. 306 Hamilton St.	37	40	42	47	52	55	63	87	13	53	residential corner lot beside school
9. 910 Angus Street	32	34	38	55	60	63	69	87	25	59	residential - commercial interface on busy street
10. 1268 Angus St.	39	44	48	55	59	62	64	71	14	58	residential - commercial interface on busy street
11. 1200 Block of Park Street	35	38	45	64	71	74	82	105	29	72	industrial area, located at intersection of railway track and truck route
12. 13 Thorn Cres.	33	39	43	47	50	52	63	72	4	52	residential with local traffic mostly, 500 ft. from railroad tracks

SITE NUMBER AND LOCATION	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{20}	L_{10}	L_{1}	L_{MAX}	$L_{10}-L_{90}$	L_{eq}	SITE DESCRIPTION
13. 1415 Rothwell St.	50	52	54	56	60	61	64	71	7	59	residential, 350 feet from truck route
14. 1920 Dewdney E.	39	41	45	53	60	62	70	101	17	66	residential on a busy through street, some construction in area
15. 82 Milford Cres.	34	37	40	47	53	57	65	84	17	54	residential backing on to truck route
16. Glen Elm Trailer Court	41	44	48	59	66	69	78	91	21	67	high density mobile home park 200 feet from highway
17. 181 Cambridge Ave.	44	45	49	53	54	55	56	63	6	53	residential on collector road, about 1000 feet from highway
18. 307 Cambridge Ave.	38	40	44	51	60	65	73	120	21	73	residential on corner lot adjacent to truck route

SITE NUMBER AND LOCATION	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{20}	L_{10}	L_1	L_{MAX}	$L_{10}-L_{90}$	L_{eq}	SITE DESCRIPTION
19. 1755 Hamilton St.	47	48	49	61	64	65	68	81	16	63	commercial-downtown area on one-way street.
20. Albert Street and Victoria Avenue	51	52	60	71	74	76	80	85	16	75	busy commercial intersection with traffic exceeding 40,000 vehicles per day
21. 1757 McIntosh St.	38	39	41	45	48	51	65	88	10	48	residential with local traffic
22. 1900 Courtney St. (normal airport operation)	25	28	31	46	65	73	82	93	42	69	rural site on city outskirts, directly under flight path
1900 Courtney St. (during airport strike)	24	26	29	38	44	49	68	90	20	56	
23. 2160 Cornwall St.	40	41	43	48	51	52	60	79	9	51	commercial residential area in downtown core area
24. 2636 Robinson St.	40	42	44	47	48	50	56	63	6	49	old residential area with local traffic only

SITE NUMBER AND LOCATION	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{20}	L_{10}	L_{1}	L_{MAX}	$L_{10}-L_{90}$	L_{eq}	SITE DESCRIPTION
25. 1521 13th Avenue	42	45	46	53	56	58	62	68	12	55	residential, adjacent to hospital zone
26. Legislative Grounds	40	42	44	51	53	55	64	80	11	53	park area
27. Broadway & McDonald	38	40	42	54	65	69	75	96	27	65	residential intersection, heavily used
28. 98 Portland Cres.	30	34	46	57	62	65	73	88	19	62	residential with local traffic only - backs onto expressway
29. 3527 Garner Ave.	37	38	40	44	45	48	57	69	8	48	quiet residential near airport
30. 3668 Edward St.	31	35	42	50	54	57	70	103	15	65	isolated residential directly under flight path

SITE NUMBER AND LOCATION	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{20}	L_{10}	L_{1}	L_{MAX}	$L_{10}-L_{90}$	L_{eq}	SITE DESCRIPTION
31. 11 Hudson Drive	32	35	40	48	51	54	66	100	14	63	residential with mostly local traffic, near flight path
32. 117 Langely St.	32	36	40	45	48	50	60	81	10	50	quiet residential
33. 87 Sunset Drive	33	34	38	44	48	49	59	70	11	50	residential, collector roadway, under flight path
34. 4 Flamingo Cres.	32	35	40	47	50	52	62	80	12	51	residential corner lot on local streets
35. 1724 Grant Drive	30	32	36	43	47	48	61	70	12	50	residential corner lot on collector roadways
36. 83 Arlington St.	46	48	52	55	58	57	63	78	5	57	residential collector roads, 1500 feet from highway

SITE NUMBER AND LOCATION	L_{MIN}	L_{99}	L_{90}	L_{50}	L_{20}	L_{10}	L_{1}	L_{MAX}	$L_{10}-L_{90}$	L_{eq}	SITE DESCRIPTION
37. 272 Lockwood Road	40*	41	45	52	57	59	63	77	14	57	residential, 300 ft. from highway with low earth berm
38. Pense, Sask. (not shown)	25	27	30	41	52	56	62	88	26	54	quiet rural town about 1500 feet from train tracks
39. 300 McDonald St.	44	47	53	61	68	71	82	97	18	69	very busy arterial in industrial subdivision, high ratio of heavy trucks.
40. 3200 Block Park Street	31	35	38	56	62	66	72	90	28	62	mounted on pole 150 feet from express-way on a busy street.
41. University Park Drive	30	31	33	43	54	60	70	88	27	58	residential collector
42. Edgar & 8th Ave.	40	42	44	48	53	57	71	89	13	59	very little local traf-fic, sound climate determined by railroad and nearby busy street
43. 1200 Block Royal Street	34	36	38	47	54	58	67	85	20	56	residential street

Monitoring Locations